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JUN 2 2 1998

Mr. Chuck Cesar
Bureau of Land Management
P. O. Box 68
Kremmling, Colorado 80459

JUN 2 2 1998

Dear Chuck:

Thank you for meeting with Jana Varner and me last month concerning water measurement at Arapaho National Wildlife Refuge and Hebron Wildlife Management Area. The waste gate is not a standard measuring structure but it does serve as a ratable channel section and can be calibrated through a series of head and discharge measurements. You and Paula will need to install a staff gage at the upstream end of the gate and make a series of discharge measurements at various heads. The stage/discharge point pairs can then be plotted and a rating curve developed. Since the curve may not be a straight line on either linear or logarithmic scales, I suggest you send the point pairs to me and I will use my software in deriving a rating table.

At the time of our visit, we were unable to measure discharge because the stage of the water, 0.05 feet, was not high enough for the Marsh McBirney to register a velocity. However, the flow appeared to be around 0.02 feet per second, and combined with a cross-sectional area of 0.245 ft², the discharge was approximately 0.005 cubic feet per second or 2 gallons per minute. In order to more accurately measure discharge at very low stages like the one we saw, you will probably want to use the volumetric method. For the volumetric method, you will want to channelize the flow with sandbags, dirt, and a pipe, and measure the amount of time required to fill a gallon bucket. You may have to wait awhile for the flow to equalize after channelizing the flow.

If there are periods where stoplogs are inserted and water is freely flowing over the top board, the structure will reasonably serve as a sharp-crested suppressed rectangular 4.9-foot weir. The following equation would provide an approximate flow value:

$$Q = 3.33(4.9)H^{1.5}$$

where Q is discharge in cubic feet per second and H is head over the top of the board. Because the head on top of the board is affected by drawdown, it is recommended that the head be measured upstream, which would require knowing the elevation of the board and

subtracting it from the gage height reading. However, for your purposes, it would probably be sufficient to just use the height of water above the top of the board.

A staff gage can be purchased from the U.S. Geological Survey Hydrologic Instrumentation Facility. Enclosed is a sheet with the gage description and HIF address/phone number.

Also enclosed with this letter is the U.S. Bureau of Reclamation's WINFLUME program. This program will help you design a long-throated flume. The Bureau of Reclamation is pushing the long-throated or "ramp" flume as the measuring device of choice for flat areas and it may be something you will want to consider. The software is the Windows 95 version - there are also Windows 3.1 and DOS versions available, if you do not have Windows 95. You will need to copy all four disks onto your hard drive and start the program using the winflume.exe command. In order to use this program, you need to be somewhat familiar with water-flow terminology and you may wish input from Paula or me. Supposedly, the ramp flumes are "easy" to construct and a reputable construction outfit should be able to do the job. If you want to go with a pre-fabricated flume, you may want to consider the cutthroat flume instead of the Parshall, although it may still require more upstream freeboard than your ditches will offer. A description of the cutthroat flume is in the Plastifab literature, which you should have received by now.

Jana or I will probably go up to Arapaho later this summer, in order to recheck the ratings for the MacFarlane Reservoir outlet ditches. Please call me if you want to get together while we are up there. If you have any questions concerning this letter, please call me at (303) 236-5322, x273.

Sincerely,

s/ PATTI FIED[illegible]

Patti Fiedler
Hydrologist

Enclosures

cc: Arapaho NWR

bcc: WR rf
RO rf
GARD CO
WTR:PFiedler:ca:6/19/98